ATRIPLEX PATULA VAR. HASTATA SEED DIMORPHISM

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Seeds were collected from a population of *Atriplex patula* var. *hastata* (L.) Gray on October 3, 1964 from saline marshes surrounding Lincoln, Nebraska (Ungar, Hogan, and McCelland, 1969). The seeds contained in bracteoles were dimorphic, both light and dark colored forms being found. The dark colored seeds had a hard black testa while the light colored seeds appeared naked and yellowish-brown. A check of taxonomic manuals, Gleason (1952), Fernald (1950), Gleason and Cronquist (1963), Rydberg (1932), and Mason (1957) does not indicate any seed dimorphism in *A. patula* var. *hastata*. Beadle (1952), in an ecological study of several Australian *Atriplex* species, found that two, *A. inflata* and *A. semibaccata*, produced both soft and hard seeds. In a study of several other *Atriplex* species introduced to Canada, Frankton and Bassett (1968) illustrate for *A. patula* var. *hastata* what appears to be a large naked seed and a smaller seed containing a hard seedcoat, with the larger seed possessing a larger bracteole than the smaller. The introduced species described by Frankton and Bassett, *A. heterosperma* Bunge, *A. oblongfolia* Waldst. et Kit., and *A. hortensis* L. were dimorphic in seed form, having a larger yellowish-brown seed, 2-4 mm in diameter, depending upon the species, or a smaller seed, 1-2 mm in diameter, with a hard black testa. Quantitative data concerning seed form and germinability is provided in this present study for *A. patula* var. *hastata* which occurs in North America.

Measurements were made with a binocular microscope, containing an ocular micrometer, of 100 seeds of each morphological type. The soft, yellowish-brown seeds range from 1.4 to 2.5 mm in diameter and have a mean diameter

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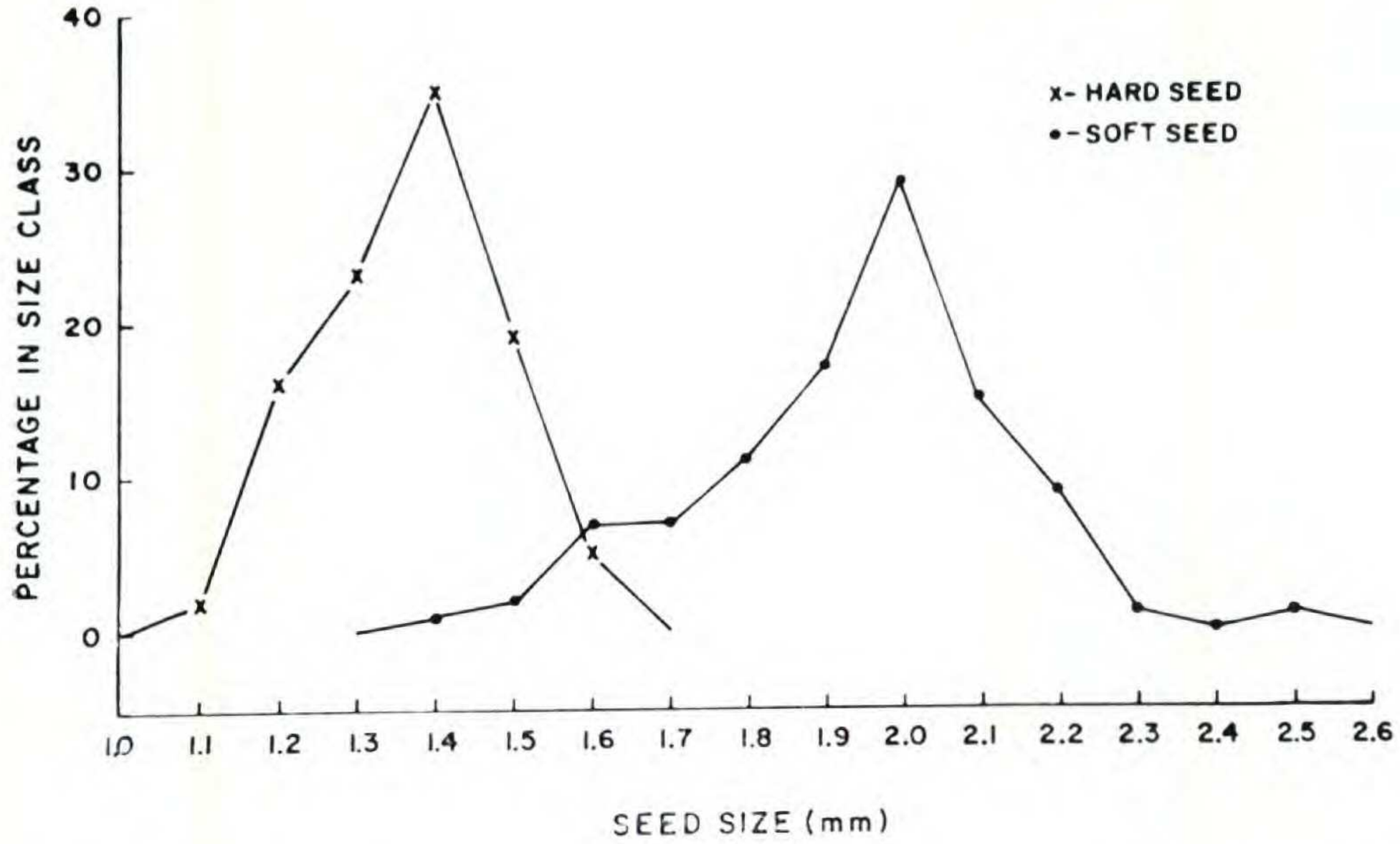

Figure 1. Seed size dimorphism in *Atriplex patula* var. *hastata*.

of 2.0 mm. Hard, black seeds range from 1.1 to 1.6 mm in diameter and their mean diameter equals 1.4 mm. A t test analysis indicates that differences in seed diameter are significant at $P \leqslant 0.01$ (Figure 1). Measurements of bracteoles indicate that black seeds can be found in those ranging from 1.0 to 4.0 mm in length and yellowish-brown seeds in bracteoles ranging from 2.6 to 5.0 mm in length.

Preliminary seed germination studies, using 100 seeds of each type, in December, 1967 on three year old seed indicated that only yellowish-brown seed germinated while the black seed had a dormancy. It was found that scarification of the black seed-coat would break this dormancy. Germination percentages for yellowish-brown seed averaged 43% at this time. A study of six year old seed in December, 1970, using 100 seeds of each type gave different results. Four groups of 100 seed were germinated, scarified and unscarified, yellowish-brown and black. Black unscarified seed had 0.0% germination, while the black scarified seed appeared to have retained a high viability, 73% germination (Table 1). The yellowish-brown seed did not retain their high viability, 43%, over the six year refrigerated storage

period, having only a 6% germination over the 20 day germination period. These data are in agreement with the results of Beadle (1952) for Australian *Atriplex* species.

Table 1. Germination percentages of dimorphic seed after six years of dry refrigerated storage.

Days	5	10	15	20
% Soft Seed	5	5	6	6
% Unscarified Hard Seed	0	0	0	0
% Scarified Hard Seed	46	68	72	73

Seed dimorphism may play a very significant role in determining survival of halophytic annual species such as *A. patula* var. *hastata*. In areas of low rainfall seedlings developing from soft seeds may perish due to inadequate moisture, while hard seeds which do not germinate immediately are less liable to die. A low rainfall period may be enough to support germination but inadequate for completion of growth. Seeds with soft testa will germinate and have no initial dormancy, although the hard, black seeds will germinate only after the testa is scarified. The black seeds are therefore more resistant to short term environmental hazards. As indicated by these laboratory studies black seeds retain their ability to germinate for longer periods and therefore can be stored in the soil for longer periods. Since *A. patula* var. *hastata* occurs in saline soils, a dormancy allows seeds to overcome periods of high salinity stress and resume germination when the soil moisture stress is reduced. Beadle (1952) reports 0% germination of light colored seeds of *A. inflata* and 28% for dark seed after a six year storage period, while freshly collected seed had 100% germination. Another Australian species, *A. vesicaria*, had 92% initial germination of light seed while after six years only 44% germinated. These results are similar to the data found for *A. patula* var. *hastata* which had 73% germination for scarified black seed and 6% germination for unscarified and 29.0% for scarified light seed after six years. Evidently the larger, soft, yellowish-brown seed be-

come more dormant in storage while the hard black seeds retain the ability to germinate for long periods. Seed dimorphism probably has survival value in extreme environments and in the evolution of seed in *Atriplex* species both a rapidly germinating and a dormant form of seed have developed.

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